Title
Queue-Based Head-End Advertisement
Scheduling Method And Apparatus

Related Application

This patent application is based on and claims priority to U.S. Provisional Patent Application No. 60/229,156, filed on August 31, 2000, entitled **"Method and System for Addressable and Program Independent Advertising"**, which application is incorporated herein by reference.

Field of the Invention

The invention pertains to advertising. More particularly, the invention pertains to targeted advertising in television programming or other media delivery systems.

Background of the Invention

_____As used herein, the term "television service delivery system" refers to any method and/or apparatus for delivering television programming to viewers, including, but not limited to, digital broadcast satellite (DBS), analog cable networks, digital cable networks, switched digital video (SDV) networks delivered via a telephone connection, and land-based radio frequency antenna broadcast.

The various modes of delivering television service, including those mentioned above, are herein termed "transport mechanisms" or "transport streams". The term "television

service provider" refers to an entity that provide television

service delivery systems, e.g., a local cable television company

in the case of analog or digital cable. The term "subscriber"

refers to any individual, household or other entity that

5   receives television service from a television service provider.

In almost all television service delivery systems other than

land-based antenna broadcasts, the subscriber actually enters

into a service contract with the television service provider in

order to subscribe to the television service. In land-based

10   antenna television service, anyone with a television in the

geographic area reached by the broadcaster can receive the

television service without any contract with the broadcaster.

Nevertheless, in this specification, the term "subscriber" is

intended to include such entities. The term head-end refers to

15   the node of the network or other television service delivery

system from which television programming is transmitted to the

receiving nodes, i.e., to the subscriber nodes.

Television service delivery systems typically deliver a

plurality of channels of television programming to subscribers.

20   The subscribers, through channel selection via a set-top box

(STB) or through the tuner of the television itself, select one

or more of those channels to view at any given time.

Traditionally, television service providers transmit the same

data on each channel to all of its subscribers. Specifically,

25   each programming channel contains the exact same content,

including advertisements, for all subscribers.

Many television service delivery systems, including analog cable, digital cable, DBS and SDV employ STBs that the subscriber must couple between the incoming signal (e.g., the cable, antenna or telephone line) and his or her television set(s). These STBs can provide substantially enhanced functionality to the television service provider as well as the subscriber. For instance, the STBs can be programmed to either allow or not allow the subscriber to view certain programming channels. As is well known to any cable television subscriber, certain channels are considered premium channels and cost extra to receive. Thus, if a person selects to receive certain premium channels, the subscriber's STB is programmed to de-scramble those channels (if transmitted in a scrambled format) or otherwise not block the subscriber's ability to view them.

Most television channels include both programming and advertisements interspersed throughout the programming. Typically, a particular advertiser will purchase a particular "spot", i.e., an advertising opportunity in a particular channel at a particular time, based on the likelihood that members of that advertiser's target audience will be watching that particular channel at that particular time. For instance, advertisers typically have a particular demographic group of individuals that they wish to reach with their advertising. For example, the manufacturer of a low-cost beer probably has a primary target audience of males between the ages of 21 and 39, living in households with a household annual income of less than $75,000 per year. As another example, a manufacturer of laundry

detergent may have a primary target audience of women between 19-59 years of age with no particular preference regarding household income. As another example, a manufacturer of expensive beer may wish to have a target audience similar to

5   that of the manufacturer of low-cost beer in that it comprises males between the ages of 21 and 39. However, this manufacturer's target demographic audience may include a different economic profile, e.g., males between the ages of 21 and 39, living in households with annual household incomes of

10 over $60,000 per year. Another advertiser that manufactures children's toys appropriate for children between 5 and 10 years of age might have a target audience of children between the ages of 5 and 10 and, depending upon the particular toys, a desired annual household income range.

15 Factors such as time of day and the particular program that is being broadcast on a particular channel can be used as predictors of the type of persons likely to be watching the television and particular channel when a particular advertisement is displayed. For instance, children are more

20 likely to be viewing television during the daytime than adults. Further, men are more likely to be watching sporting events than women. However, time of day and type of program are not perfect indicators of the viewing audience. For instance, Monday Night Football traditionally would be considered a program/timeslot

25 that would present advertisers with a large number of male viewers between the ages of 21 and 39. However, those viewers are likely to span the entire annual household income range.

Accordingly, a large portion of the target audiences of both the low-cost beer manufacturer and the premium beer manufacturer can be expected to view Monday Night Football. However, by the same token, both beer manufacturers will pay a premium price to

5 advertise during Monday Night Football, even though a large portion of the audience does not comprise their target audience. For instance, the premium beer manufacturer will be reaching many men living in households within a lower income range who are unlikely to purchase the premium beer because of its high

10 cost. That manufacturer nevertheless pays the premium price for that advertising spot.

Accordingly, it is an object of the present invention to provide an improved method and apparatus for advertising in television and other media.

15 It is another object of the present invention to provide a method and apparatus for more narrowly reaching one's target audience in television advertising.

It is a further object of the present invention to provide a method and apparatus by which advertisements can be inserted

20 into television programming channels in a more targeted fashion than traditional advertising mechanisms.

Summary of the Invention

The invention is a method and apparatus for delivering

25 targeted advertising to persons who receive a media stream such as television. While the invention is particularly suitable for use in connection with television service delivery systems, and

particularly those utilizing STBs or the equivalent, it can be applied to other media streams such as the Internet, and audio-only streams that might be delivered via DBS, analog cable, digital cable or SDV.

5   In accordance with the invention, for each channel containing different television programming, a television service provider transmits multiple versions of that channel in which the programming is identical but the advertisements are different. This allows television service providers to offer

10   advertisers more targeted advertising other than simply based on channel, time of day, and programming. For instance, a single programming channel, e.g., VH1, can be duplicated four times at the head end of a television service network to create four presentation channels. Different advertisements can be inserted

15   into each of the four presentation channels with the different presentation channels delivered to different groups of subscribers. The subscriber groups may be grouped by nodes of a cable television network with the provider delivering the different presentation channels to different nodes.

20   Alternately, subscriber groups may be created by transmitting all presentation channels to all subscribers, but individually programming the set-top boxes of the individual subscribers to pick out a particular one of the multiple presentation channels corresponding to each programming channel.

25   The set-top boxes can be programmed before being delivered to the subscribers or can be programmed by the provider via the

communication network after they are coupled to the network by
the subscriber.

In accordance with the invention, the television service
provider inserts different advertisements into the different
5   presentation channels at the head end using a queue-based method
and apparatus. In accordance with the invention, a queue of
advertisement resource locators (ARLs) is maintained for each
transmitted presentation channel. In a simple embodiment, there
is one queue for each presentation channel. The ARLs comprise
10   information disclosing the location of a corresponding
advertisement. The actual advertisements are stored elsewhere
and preferably are stored in a digital format such as MPEG.
They may be stored in a memory local to the head end of the
television service delivery system or may be stored elsewhere
15   accessible by the head end computer system via the television
service delivery network or a separate communication network.
At the simplest level, ARLs essentially comprise pointers to the
actual advertisements.

ARLs are stacked in the queue in the order in which they
20   are to be inserted into the corresponding programming channel.
The avails in the programming channel within which the
advertisements are to be inserted are determined by any
reasonable means and the advertisements are inserted within
those avails. For example, the television service provider may
25   be given data in advance disclosing where the avails are in the
programming channel. In other embodiments, the beginning of

avails may be indicated by a predetermined signal in the
vertical blanking interval of the video stream or by cue tones.

Brief Description of the Drawings

5   Figure 1A is an exemplary system-wide advertisement group
map in accordance with the present invention that may be stored
at the head end for transmission to the set-top boxes in order
to enable the set-top boxes to formulate their own individual
channel maps.

10   Figure 1B is an exemplary system-wide channel map that may
be stored at the head end for transmission to the set-top boxes
for purposes of creating their individual channel maps.

        Figure 1C is an exemplary individual channel map for a
particular STB in accordance with the present invention.

15   Figure 2 is a logic diagram illustrating an advertisement
resource locator queue stored in memory in accordance with the
present invention.

        Figure 3 is a logical representation illustrating
advertisement insertion into a plurality of presentation

20 channels corresponding to one programming channel in accordance
with the present invention.

        Figure 4 is a block diagram of a queue-based, head-end
advertisement scheduling and insertion apparatus in accordance
with one embodiment of the present invention.

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Detailed Description of the Invention

In accordance with the invention, a television service provider (TSP) receives a plurality of television programming channels (e.g., ABC, NBC, CBS, FOX, UPN) containing television programming as well as spaces interspersed within the programming for advertisements. Such advertisement intervals are herein termed "avails". Some, all or none of the avails may be filled with advertisements as delivered to the television service provider, while some all or none of the avails may be empty with the intent that the TSP insert advertisements into them. The advertisement insertion scheme of the present invention may be used to insert advertisements either into only the empty avails in a programming channel or to replace some or all of the advertisements that are already in some of the avails as delivered to the TSP.

One or more of the incoming programming channels is replicated, for example, by an audio/video splitter circuit, to produce multiple identical output channels. The same process is repeated for any number of other programming channels.

In accordance with a preferred embodiment of the invention, the selection of the particular presentation channel when a viewer selects a particular programming channel is transparent to the subscriber/viewer. That is, the subscriber selects only a particular programming channel, e.g., ABC, and the set-top box picks a particular one of the multiple presentation channels corresponding to ABC, e.g., ABC_1, ABC_2, ABC_3 or ABC_4.

This can be accomplished in many ways depending on the available bandwidth for transmitting television channels to the

subscribers, the particular transport mechanism and other

factors. In one scheme preferable for high bandwidth transport

mechanisms such as analog cable, digital cable and DBS, all of

the presentation channels are transmitted over a high bandwidth

5   mechanism and each of the subscribers has a set-top box or other

mechanism programmed to select one of the presentation channels

corresponding to each programming channel.

A similar scheme can be employed in an SDV system with

slight modification. As is well known, in SDV systems, in which

10   bandwidth is much more limited than in cable systems, typically

only one or a few channels can be transmitted to a subscriber at

any given time. Accordingly, whenever a subscriber selects a

programming channel to view, a signal is sent from the

subscribers STB to the head-end or to a curb side node of the

15   network asking for the selected channel to be transmitted to the

subscriber. Accordingly, in SDV systems, the scheme may be

essentially identical to that described above for cable

networks, except that, instead of picking out the particular

presentation channel corresponding to the selected programming

20   channel for the advertising group to which that subscriber has

been assigned, the STB is programmed to request the particular

presentation channel from the head end. This SDV scheme can be

implemented on commercially available SDV systems including the

NLevel[3] platform which is manufactured and sold by Next Level

25   Communications.

In accordance with the invention, each subscriber is

assigned to an advertising group wherein the assigned

advertising group dictates which of the presentation channels corresponding to each programming channel that subscriber will receive when selecting that programming channel.

One preferred method is for each subscriber to have a set-top box which has stored in memory a tag identifying the advertising group to which it belongs. This tag may be programmed into the STB memory by the television service provider before it is delivered to the subscriber. Alternately, the STB may be programmed to accept data assigning it to a particular advertising group via the television service delivery system itself. In one embodiment, one channel in the transport mechanism (preferably a low bandwidth channel) can be reserved for sending advertising group assignments and other instructions to the set-top boxes.

Each set-top box can be assigned a unique identification code which can be used in conjunction with system-wide channel and advertising group maps received over the instruction channel to determine its advertising group. An advertising group map may be generated at the head end and transmitted over this instruction channel to all subscribers.

Figure 1A illustrates an exemplary advertising group map 101 that may be stored at the head end and transmitted via the instruction channel to all of the subscribers in an SDV television service system. The map identifies an advertising group 103 for every STB on the system. Each individual STB receives the map 101 and matches its identification number to an identification number 105 in the map to determine to which

advertising group it belongs. Figure 1B illustrates a
presentation channel map 111 which also may be broadcast from
the head end to all STBs. As shown in Figure 1B, the
presentation channel map identifies which presentation channel

5   113 for each programming channel 115 corresponds to which
advertising group. It also identifies the information 117
needed by the STBs to tune into the particular presentation
streams.

Figures 1A and 1B illustrate a presentation channel map for

10 an SDV system utilizing the telephone lines and very high speed
digital subscriber lines (VDSL) modems. As well known in the
SDV art, the unique STB identifiers are Media Access Control
Identifications (MAC_IDs) and the presentation channel tuning
information 117 comprises a virtual identifier/virtual channel

15 identifiers (VPI/VCIs) 117. In other systems such as analog
cable, digital cable and DBS, the STB identifiers could take any
reasonable form and the presentation channel information 117
could be the particular frequencies to which the individual
presentation channels correspond, rather than VPI/VCI

20 identifiers.

By correlating the data received in the advertising group
map of Figure 1A and the presentation channel map of Figure 1B,
each individual STB can create an individual channel map 121 for
itself as illustrated in Figure 1C.

25 Figure 1C illustrates the map 121 which will be built by an
STB assigned to advertising group C. The map indicates which
particular VPI/VCI 123 (i.e., presentation channel 125) to

select when the user selects a particular programming channel 127.

In systems which are not based on ATM but instead use analog video channels or digital video streams (e.g. MPEG) to transport video, the channel map will refer to a particular frequency (in the case of analog video) or a particular Program ID (PID) in the case of MPEG.

The particular advertising group to which each subscriber is assigned may be chosen by the television service provider based on available information about that subscriber that is relevant to the type of advertising most beneficial for that subscriber. Such information may include publicly available probabilistic demographic and/or psycho-graphic information based on the address of the subscriber. For instance, a handful of marketing firms in the United States provide information about fixed groups known as "clusters" for use by advertisers in identifying members of their target audiences. "Clusters", well known in the field of advertising, are groups of neighborhoods in the United States having certain similar characteristics such as socio-economic, demographic and/or psycho-graphic characteristics. To form clusters, these marketing firms have examined the characteristics of all known neighborhoods in the country using census or other publicly available data, have selected certain grouping characteristics (e.g., average family income, average family age, etc.) and have combined some of the neighborhoods with similar grouping characteristics into clusters. Examples of marketing firms known to provide

"cluster" services are Claritas Inc., with its PRIZM™ cluster

system identifiable by zip+4 codes, CACI INC., with its Acorn™

system, and National Decision Systems, Inc., with its Vision™

system.

Alternately or additionally, subscribers may simply be

asked to fill out questionnaires disclosing such information

such as age and gender, ethnicity and income of the members of

the household when they sign up as subscribers with the

television service provider.

In one embodiment of the invention, each programming

channel is split into the same number of presentation channels

as there are advertising groups. However, there is no

requirement that all of the programming channels be split into

multiple presentation channels or that those that are split into

multiple presentation channels be split into the same number of

presentation channels. In fact, there may be more advertising

groups than presentation channels corresponding to any single

programming channel.

In accordance with the present invention, the schedule for

inserting advertisements into each of the presentation channels

is achieved by using a queue stored in memory. Figure 2 is a

pictorial representation of a queue in accordance with the

present invention. The queue 200 is a stacked list of

advertisement identifiers, hereinafter termed advertisement

resource locators (ARLs) 202. At a minimum, the ARLs indicate

the location of a particular advertisement, which may be a

memory address in a large volume memory local to the head end of

the system. Alternately, the ARLs may point to a remote server
on a network to which the head end computer is coupled. For
instance, the advertisement may be stored at a remote location
on the advertisers server, to which the television service

5   provider is coupled via a network. Such an embodiment is
advantageous in that any changes that the advertiser wishes to
make to the advertisements, including substituting an entirely
new advertisement for an older one, can be made by the
advertiser on the advertiser's server any time before the

10   advertisement is accessed for display, without the need for the
television service provider's attention.

Preferably, the ARLs also indicate other information about
the advertisement, such as the duration of the advertisement,
the identity of the advertiser and the identity of the

15   particular advertisement, which information may be useful for
purposes of billing advertisers for display of their
advertisements.

In a preferred embodiment of the invention, the queue
comprises a stack of ARLs in the order in which they are to be

20   inserted into the corresponding presentation channel. However,
it will be understood by those of skill in the related arts that
the "order" of the ARLs need not necessarily correspond to the
numerical addresses of the ARLs in the queue, but encompasses
any ordering algorithm that may be used to retrieve ARLs from

25   the queue. For instance, the ARLs may include a time tag
indicating the time that the corresponding advertisement is to
be inserted into the presentation channel.   U.S. Patent

Application No. 09/635,542, entitled "Grouping Subscribers Based On Demographic Data", filed on August 10, 2000, assigned to the same assignee as the present application and incorporated herein by reference, discloses a television service delivery method and apparatus into which the present invention can be incorporated.

Figure 3 illustrates dynamic substitution and insertion of advertisements in one presentation channel in accordance with the present invention. As shown in Figure 3, there exists a first programming channel 901 having programming segments 903, 905, 907 and a plurality of advertisement segments (i.e., avails) 909, 911, 913, 915, 917, 919, 921, 923. The start of each avail is determined by any available scheme such as detection of digital cue tones, detection of a blank picture for a predetermined duration (which usually indicates the beginning of a commercial break in television programming), or detection of a predetermined signal in the vertical blanking interval. The aforementioned provisional application as well as U.S. patent application No. 09/712,790, filed on or about November 14, 2000, entitled "Queue Based Advertisement Scheduling and Sales", incorporated herein by reference, discuss these and other ways of determining the location of avails in a programming channel. Alternately, the television service provider simply may have a schedule indicating the times of all upcoming avails in the programming channel.

When the beginning of an avail, e.g., avail 917, is detected or otherwise determined by the AIS in the data stream 901, the AIS retrieves the appropriate advertisement (as

determined by consultation of the queue) from memory 803 and inserts it into the avail 917.

Figure 4 is a block diagram of a head end advertisement insertion module in accordance with the present invention for an exemplary SDV system. Figure 4 is merely exemplary of one particular potential embodiment of the invention and is not limiting. An advertisement insertion subsystem (AIS) 801 coupled to an advertisement management subsystem (AMS) 805 is provided. The AIS 801 receives one or more programming channels, e.g., ABC, NBC, CBS, FOX, UPN, and creates a plurality of presentation channels, e.g., ABC_1, ABC_2, ... , ABC_n, ... ,NBC_1, NBC_2, ... , NBC_n, ..., UPN_1, UPN_2, ..., UPN_n, based upon instructions received from the AMS 805. Each programming channel comprises entertainment programming and one or more advertising avails within which the television service provider is to insert advertisements. The AIS 801 splits each incoming programing channel into a plurality of presentation channels, such as by passing the incoming programming channels through audio/video splitters (not shown).

The AMS 805 is coupled to a demographic database 809 and a subscriber billing records database 807, wherein the demographic database 809 may be one of the aforementioned commercially available databases having demographic information about subscribers.

The AIS 801 and the AMS 805 both are connected to a distribution network 813. The AIS 801 provides the multiplicity of presentation channels to the distribution network 813 and the

AMS 805 provides instructions about advertising group associations of STBs, e.g., the afore described advertising group maps and channel maps, via an AMS_STB interface 811.

The AMS 805 also is connected to a broadband interface 815 via a mapping subsystem 817, wherein the mapping subsystem 817 assists in mapping different channels to different programming, e.g., STB group mapping.

The broadband interface 815 is connected to one or more subscribers 825 via an access network 819. In one embodiment, each subscriber 825 has an STB for the reception of entertainment programming and advertising.

The AIS 801 is responsible for creating n presentation channels from each selected programming channel, each presentation channel containing targeted advertisements corresponding to the presentation channel's advertising group.

The AIS 801 forms the presentation channels by "replicating" the programming channel into a plurality of presentation channels and inserting targeted advertisements into the advertisement avails in the presentation channels. In order to accomplish this targeted advertisement insertion, the AIS 801 receives from the AMS 805 instructions on which advertisements should go into which avails in each of the presentation channels. These instructions are derived from consultation with the queues as previously described. The AMS 805 also supplies instructions to the AIS 801, with reference to matching advertisements to avails, based on the prior sale and scheduling of those avail/advertisements combinations.

The AIS 801 must report to the AMS 805 exactly which advertisements were played in which avails and in which presentation channels such that the purchaser of the advertisement/avail combination can verify that the

5   advertisement was successfully inserted and be billed for the completed transaction.

The AMS 805 has direct access to subscriber records, e.g., subscriber billing records. The subscriber billing records 807 provide the AMS 805 with the information regarding subscribers

10   necessary for determining subscriber profiles and for the targeting of advertisements. For example, in order to optimally utilize the demographic data, a subscriber's ZIP+4 information is needed, and this information is derived from the actual physical address of the subscriber stored in the subscriber

15   billing records 807.

To utilize the system of Figure 4 in a switched digital video environment, a Media Access Control Identification (MAC_ID) of the STB (i.e., a unique identification of a particular STB) of each subscriber will also be needed. The

20   unique MAC_ID is used by the broadband interface 815 to identify which STB is sending or is receiving information. The MAC_ID is needed so that the STB itself may be 'informed' about the relevant advertising group. As mentioned above, in one embodiment, a single and complete presentation channel map will

25   be broadcast from a broadband terminal to many STBs. The individual STBs will compute their own individual channel maps based on the group to which they belong.

It is to be noted that increasing the number of presentation channels necessary to accomplish targeted advertising also results in an increased number of channels (i.e., VPI/VCIs) entering and switched by the broadband interface 815, and potentially received by the STB. The broadband interface 815 uses the presentation channel map such that it knows which actual presentation channel corresponds to each VPI/VCI. This map is also sent to the STBs so that the STBs can form their own individual channel maps according to their group, as previously described. The map between channels and VPI/VCIs is generally 'synchronized' between the broadband interface 815 and STB such that a channel change at the STB results in the correct switching of the presentation channel by the broadband interface 815.

As mentioned above, the presentation channel map is communicated to the broadband interface 815 via the mapping interface 817. The AMS 805, alternately, may contain the advertising grouping information about subscribers (and about their STBs).

As avails are determined in each presentation channel, the AMS 805 consults the queue corresponding to that presentation channel to determine which advertisement is to be inserted into that avail and informs the AIS 801. The AIS retrieves the advertisement from the large volume memory 803 and inserts it into the avail in the presentation channel.

There are numerous ways in which the advertisements can be inserted into the presentation channels that would be readily

apparent to persons of skill in the related arts. For instance,
a digitally controlled video switch may simply switch the source
between the presentation channel and an advertising stream (from
the large volume memory 803) at the beginnings and ends of
avails. This insertion can also be accomplished using a number
of commercially available units including those produced by the
Sea Change Corporation and by nCube of Foster City, California,
U.S.A.

The various blocks shown in Figure 4 may be implemented by
any reasonable circuitry, including, but not limited to, a
programmed general purpose computer, a digital signal processor,
an application specific integrated circuit, analog circuitry, a
remote state machine or any combination of the above.

Countless alterations are possible in practicing the
present invention. Depending upon a particular household, the
individual advertising map created for the STB may be more
complex than those illustrated in Figures 1A-1C, so that the STB
selects presentation channels corresponding to different
advertising groups depending on additional conditions such as
time of day or the particular program. For instance, let us
consider an example in which advertising group C is designed to
probabilistically present advertisers with males between the
ages of 21 and 39, while advertising group B is designed to
probabilistically present advertisers with females between the
ages of 21 and 39. If a household comprises a husband (who is
most likely to be the viewer when the STB is tuned into a sports
channel such as ESPN) and a wife (who is more likely to be the

viewer when the STB is tuned into a programming channel like LIFETIME), the individual channel map for that subscriber should be different than for a household comprising two men rather than a husband and wife. Thus, the channel map for the former

5 household may select the presentation channel corresponding to advertising group C (i.e., ESPN_C) for programming channel ESPN, and select the presentation channel corresponding to advertising group B (i.e., LIFETIME_B) for programming channel LIFETIME. The channel map for the latter household, on the other hand, may

10 select the presentation channel corresponding to advertising group C for both ESPN and LIFETIME.

Alternately or additionally, the individual group map may be time-of-day dependent. For instance, if it is somehow probabilistically determined that, for a particular subscriber

15 household, one or more viewers within a certain demographic category are likely to view the television during a certain time of day while individuals of a different demographic category view the television at a different time of day, the individual advertising map for that STB could include time dependent

20 criteria.

Ordinarily, the advertising groups would comprise mutually exclusive sets of subscribers. However, it is possible for some overlap if additional criteria as discussed above are incorporated into the individual STB channel maps as long as the

25 situation is avoided where one subscriber node belongs to two different advertising groups for the same time period and programming channel.

While the invention has hereinabove been described in connection with advertising in television service delivery systems, it can be applied in connection with the insertion of any data into any media stream regardless of sources as long as the information stream passes through a circuit that can perform the functions described above of the advertisement insertion module 801. Thus, for instance, the invention is equally applicable to analog cable, regular earth-based broadcast television, the Internet, or a data stream from any type of memory device, including compact disks, digital video disks, other optical media, magnetic disks, ROM, RAM, etc.

Having thus described a few particular embodiments of the invention, various alterations, modifications, and improvements will readily occur to those skilled in the art. Such alterations, modifications and improvements as are made obvious by this disclosure are intended to be part of this description though not expressly stated herein, and are intended to be within the spirit and scope of the invention. Accordingly, the foregoing description is by way of example only, and not limiting. The invention is limited only as defined in the following claims and equivalents thereto.